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Olin CHEMICALS

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May 14, 1992 3 8 0701

VIA FEDERAL EXPRESS

Cheryl W. Smith
Senior Remedial Project Manager
United States Environmental Protection Agency
345 Courtland Street Northeast
Atlanta, Georgia 30365

Re: Candidate Technologies Technical Memorandum
Olin Chemicals/McIntosh Plant Site
McIntosh, Alabama

Dear Ms. Smith:

Pursuant to Section 5.5.3 of the amended Work Plan, the Candidate Technologies Technical Memorandum (CTTM) is enclosed. The purpose of this Technical Memorandum is to identify potential candidate technologies for treatment of the affected media in Operable Unit 2.

Additional sampling is planned for Operable Unit 1, and this sampling must be completed before the candidate technologies can be identified. A revised CTTM to address Operable Unit 1 will be submitted to EPA and ADEM after the sampling results have been evaluated.

Please let me know if you have any questions regarding the contents of this technical memorandum or any of the work in progress at McIntosh, Alabama.

Sincerely,

OLIN CORPORATION

J. C. Brown
Manager, Environmental Technology

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Enclosure

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CANDIDATE TECHNOLOGIES
TECHNICAL MEMORANDUM
OLIN MCINTOSH RI/FS
OPERABLE UNIT 2

1.0 INTRODUCTION

Olin Chemical Corporation is conducting a Remedial Investigation/Feasibility Study (RI/FS) at their McIntosh, Alabama facility. Candidate technologies for potential remedial alternatives are identified as part of the RI/FS. An initial step is to assess whether the identified technologies would require treatability testing in order to complete a detailed analysis of the applicability of the technologies for treatment of the affected media at the site. The identification of candidate technologies and the evaluation of whether treatability testing could be required are presented in this Candidate Technology Technical Memorandum (CTTM).

1.1 Background Information

The Olin Chemicals McIntosh plant is located approximately one mile east-southeast of the town of McIntosh, in Washington County, Alabama. A site location map is presented in Figure 1. The property is bounded on the east by the Tombigbee River, on the west by land (not owned by Olin) west of U. S. Highway 43, on the north by the Ciba-Geigy Corporation plant site and on the south by River Road.

Olin operated a mercury cell chlorine-caustic soda plant on a portion of the site from 1952 through December 1982. In 1954, Olin began construction of a pentachloronitrobenzene (PCNB) plant on an adjacent portion of the site. The plant was completed and PCNB production was started in 1956. The McIntosh plant was expanded in 1973 to produce trichloroacetonitrile (TCAN) and 5-ethoxy-3-trichloromethyl-1,2,4-thiadiazole (Terrazole®). The PCNB, TCAN and Terrazole® manufacturing areas were collectively referred to as the Crop Protection Chemicals (CPC) plant. In 1978, Olin constructed a diaphragm cell caustic soda/chlorine plant which is still in operation. The CPC plant and mercury cell plant were shut down in late

1982. The McIntosh plant continues to operate and produce chlorine, caustic soda, sodium hypochlorite, sodium chloride and blend hydrazine.

The Olin McIntosh plant currently monitors and reports on numerous facilities permitted through the U. S. Environmental Protection Agency (EPA) and the Alabama Department of Environmental Management (ADEM). These include water and air permits as well as a Resource Conservation and Recovery Act (RCRA) post-closure permit (including a groundwater corrective action pumping/treatment program), Solid Waste Management Unit (SWMU) closures, three injection wells for mining salt and a neutralization/percolation field.

In September 1984, Olin's McIntosh plant site was placed on the National Priority List of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or "Superfund." Groundwater contamination at the site has been established based on the results of various investigations. Mercury and chloroform are the principal contaminants identified at the site. Mercury contamination was evidently caused by the operation of the mercury cell chlor-alkali plant during the period 1952 to 1982. The chloroform contamination is probably a degradation product of wastes from the operation of the CPC plant from 1954 to 1982.

Investigations have also indicated contamination in a 65-acre natural basin, herein referred to as the "basin," located on the Olin property east of the active plant facilities. This basin received plant wastewater discharge from 1952 to 1974.

Two operable units have been designated for the facility. Operable Unit 1 (OU-1) is the plant area (all of the Olin property except the area defined as OU-2). Operable Unit 2 (OU-2) is the basin, including the wetlands within the Olin property line and the wastewater ditch leading to the basin. Figure 2 is a facility layout map delineating the boundaries of the two operable units.

The amended Work Plan submitted to EPA on May 25, 1991 identified seventeen closed, inactive and active Solid Waste Management Units (SWMUs) within OU-1. Subsequently, EPA conducted a RCRA Facility Assessment (RFA) at the McIntosh facility. The RFA consisted of a preliminary Review (PR) of files from EPA Region

IV and ADEM and a Visual Site Inspection (VSI). A draft RFA Report was provided to Olin on October 30, 1991. Olin made comments, and a Final RFA Report was provided to Olin on February 4, 1992. The Final RFA Report lists 52 SWMUs and six areas of concern (AOCs). The list of SWMUs in the RFA report includes the seventeen SWMUs listed in the amended Work Plan.

Due to the comparable requirements of the HSWA Corrective Action Program and CERCLA at the Olin McIntosh facility, sampling of SWMUs and Areas of Concern (AOCs) identified in the RFA is being conducted as part of the RI/FS. The details of additional sampling in OU-1 were outlined in a revised SAP that was submitted to EPA on April 2, 1992.

The nature of contamination in OU-2 has been defined by the RI site characterization activities and this information is presented in the Preliminary Site Characterization Summary (PSCS) that was submitted to EPA on April 16, 1992. Additional data are required to define the horizontal and vertical extent of constituents as outlined in the April 2, 1992 revised SAP. However, the existing data are sufficient to identify potential remedial technologies for OU-2.

More extensive sampling is planned for OU-1. The sampling is to address the Old Plant (CPC) Landfill, which was identified as a potential continuing source of groundwater contamination, and other SWMUs/AOCs identified in the RFA. The data acquired from this additional sampling will be used to evaluate the occurrence and character of the constituents in the subsurface at these SWMUs/AOCs. The identification of potential technologies for OU-1 will be based on the results of this additional sampling. Therefore, this technical memorandum addresses the candidate technologies for OU-2. A revised CTTM to address OU-1 will be submitted to EPA after completion of the planned sampling.

1.2 Scope and Objectives

The purpose of this technical memorandum is to identify potential candidate technologies for treatment of the affected media in Operable Unit 2. Potential remedial technologies were reviewed using information from vendors, case studies, other

CERCLA site studies, SITE program testing results and available literature on known treatment techniques. The technologies were evaluated as potentially applicable or not applicable.

In some cases the existing site characterization data may not be sufficient to adequately evaluate the feasibility of the potential remedial technologies. Therefore, treatability investigations or other additional data collection may be required. The potentially applicable technologies that may require treatability investigations (bench or pilot scale) are identified in this technical memorandum.

The focus of this technical memorandum is to identify the data requirements and the need for treatability investigations for potentially applicable technologies. Concurrently, general response actions are being developed and treatment technologies are being screened in more detail to assess their applicability to the site. The technology screening will be presented in the Remedial Technologies Alternative Screening Technical Memorandum as part of the feasibility study. Potential remedial alternatives will be developed for the site and screened based on short-and long-term effectiveness, implementability and cost. Detailed analyses will then be conducted for selected alternatives. The purpose of any treatability investigations is to provide information needed for the detailed analysis of alternatives to allow for selection of a remedial action to be made with a reasonable certainty of achieving the response objectives (EPA, October 1988). If an alternative selected for detailed analysis includes one or more treatment technologies that require treatability investigations as identified in this memorandum, a treatability test work plan (or amendment to the existing work plan.) will be developed. The treatability test work plan will document the methodologies, specific equipment needs and critical test parameters required to complete the treatability investigations.

1.3 Operable Unit 2 Description

Operable Unit 2 consists of the basin (65-acres), the wetlands within the Olin property line and the wastewater ditch leading to the basin. The basin is a natural feature lying within the flood plain of the adjacent Tombigbee River. During the seasonal high water levels (approximately 4 to 6 months per year), the basin is inundated by and becomes contiguous with the adjacent river.

The plant wastewater ditch currently carries the NPDES discharge and stormwater runoff from the manufacturing areas as well as the east and southeast non-manufacturing areas of Olin property to the Tombigbee River. From 1952 to 1974, plant wastewater discharge was routed through the basin and then to the Tombigbee River. In 1974, a discharge ditch was constructed (approximately 800 feet long during the non-flood season) to reroute the wastewater directly to the Tombigbee River, bypassing the basin itself.

Site characterization activities for OU-2 included a bathymetric survey, sampling and analysis of sediments and surface water, an assessment of the potential impacts to biota with a vegetative stress survey, a macroinvertebrate survey and sampling and analysis of fish. The bathymetric survey indicated that the maximum depth of the basin is 38.5 feet. Approximately two-thirds of the basin area is relatively flat with water depth less than 6 feet. The sediment samples were obtained from the basin, the current outfall ditch, the former ditch to the basin and the current discharge ditch to the Tombigbee River. The dominant constituents related to the Olin facility that were reported in the OU-2 sediments are mercury and hexachlorobenzene. The horizontal extent of these constituents has not been completely defined by the basin sampling, and additional sampling is planned. The maximum vertical extent of constituents reported in the basin is seven feet. The vertical extent of constituents has not been defined at one location in the wastewater ditch and additional core sampling is planned in this ditch.

Only two target organic compounds were reported in the surface water analyses. Chloroform was reported in one sample at an estimated concentration of 3.0 μg/l, which is below the Contract Required Quantitation Limit (CRQL). Alpha BHC (a pesticide) was reported in two samples: at 0.18 μg/l and at 0.22 μg/l. Based on the sediment and surface water results and the hydrogeologic conditions in the basin, the potential impact to groundwater in OU-2 is characterized as minimal.

More details on the results of the site characterization activities are presented in the Preliminary Site Characterization Summary, submitted to EPA on April 16, 1992.

1.4 Chemicals of Potential Concern

Table 1 summarizes the chemical of potential concern for the sediments and surface water in OU-2. Table 1 is based on the concentration-toxicity screening of the maximum concentrations reported in these media. Constituents that contribute greater than one percent of the total carcinogenic or non carcinogenic hazard based on this screening are listed in Table 1. In addition, chemicals that were detected that have a Class A carcinogen status are also included on the list. The Hazardous Substance Indicator Parameter Technical Memorandum (HSIPTM), which was submitted to EPA on December 19, 1991 included an initial list of chemicals of concern. The initial list was developed and submitted to EPA prior to completion of data validation. The list has been revised based on the validated data, incorporates EPA comments to the HSIPTM and is presented in Table 1. Other constituents reported in the sediments and surface water that are not on the chemicals of potential concern list will be addressed qualitatively in the Baseline Risk Assessment.

1.5 Remedial Action Objectives

The amended Work Plan that was submitted to EPA on May 25, 1991 identified preliminary Remedial Action Objectives (RAOs). A Revised Remedial Action Objectives Technical Memorandum was submitted to EPA on April 30, 1992 based on the results of the site characterization activities and an evaluation of the potential Applicable or Relevant and Appropriate Requirements (ARARs). Table 2 summarizes the RAOs for Operable Unit 2 for the potentially affected media. This Candidate Technologies Technical Memorandum address the potential technologies for addressing the sediments and surface water in OU-2.

1.6 Basic Assumptions

Chloroform, benzene, the chlorinated benzenes and the chlorinated pesticides are identified as the primary organic constituents in the sediments. Mercury is identified as the primary inorganic constituent with lesser concentrations of other inorganic analytes. The reason that the compounds listed here do not correspond directly to the list in Table 1 is that the chemicals of potential concern list was developed based on the maximum concentration reported and also the toxicity factor. For purposes of identifying candidate treatment technologies, organic compounds and metals were considered as general groups of compounds that may require treatment. Candidate technologies are not listed specifically to treat the surface water due to the relatively low concentrations that were reported. Water treatment associated with the sediment treatment processes is addressed, however, and these water treatment technologies would be applicable for surface water.

Since the sediments contain both organics and inorganics, combinations of technologies or treatment trains may be required to successfully treat the wastes. These treatment trains are not identified at this point. It is assumed that the need for treatability testing can be accurately evaluated for each technology individually.

2.0 IDENTIFICATION OF POTENTIAL APPLICABLE TECHNOLOGIES

Potential applicable treatment technologies were identified by applying engineering judgment to an extensive list of technologies provided in the Technology Screening Guide for Treatment of CERCLA Soils and Sludges, U. S. EPA, September 1988, and the Superfund Innovative Technology Evaluation (SITE) Program, U. S. EPA, November 1990. (NOTE: Technologies in the SITE program are used herein, but could be eliminated by performance uncertainties in the future.) Additional technologies were added based on Woodward-Clyde Consultants experience and a literature review. A list of references is provided in Section 4.0. A more detailed evaluation of the potential treatment technologies will be conducted as part of the feasibility study.

The potential applicable technologies are summarized in Table 3, Table 4 and Table 5. The sediment treatment technologies are evaluated for in-situ treatment (Table 3) and direct treatment after removal (Table 4). Many at these treatment technologies produce process water that would require further treatment (Table 5). These technologies are further grouped into one of the following treatment categories where appropriate:

- Fixation/encapsulation
- Thermal treatment

- Chemical treatment
- Physical treatment
- Biological treatment

Fixation/encapsulation are processes by which the hazards from exposure to or leaching from wastes are reduced by containing or immobilizing the constituents within the affected sediment. Thermal treatment processes use high temperature as the principal mechanism for waste destruction. Chemical treatment refers to processes in which hazardous constituents are transformed by chemical reactions. These chemical treatment technologies are designed to destroy the hazardous constituents or convert them to a less hazardous form for further treatment or disposal. Physical treatment refers to processes that, through concentration or phase change, usually reduce or concentrate the waste volume for further treatment or disposal. The biological treatment processes utilize microorganisms to destroy the hazardous constituents or transform these constituents to a less hazardous form for treatment or disposal.

Each of the treatment categories described above can produce residuals which also may require treatment by one of the above process types and many of these technologies will require water treatment. The candidate technologies for water treatment are also identified.

3.0 DISCUSSION OF TECHNOLOGIES

This section provides a brief discussion of the treatment technology groups and their potential applicability to the site. The need for treatability investigations (bench or pilot scale) or other data requirements are also identified for each technology. It should be noted that treatability investigations (if any are required) would only be conducted on the treatment technologies that are included in the alternatives that are selected for detailed analyses based on the feasibility study.

3.1 In Situ Treatment Technologies

Several in-situ treatment technologies are potentially applicable for treatment of sediments containing the chemicals of concern (Table 3). Operable Unit 2 consists of the basin, surrounding wetlands, and the associated ditches. Where applicable, the basin and the ditches are addressed separately because treatment technologies that are suitable for one or more of the ditches may not be suitable for the basin. One factor that differentiates the basin from the ditches is that the basin supports a relatively diverse biota community. Certain in-situ treatment technologies that may be applicable for the ditches would destroy the biota or its habitat in the basin making these technologies unsuitable for the basin.

3.1.1 Fixation/Encapsulation

This technology group can be categorized into two subgroups. Containment is not considered treatment, but may be applicable and is therefore included. The containment technologies include:

Soil Capping	Natural Sedimentation
Multimedia Capping	Enhanced Sedimentation
Backfilling	Expedited Sedimentation

The containment technologies have been demonstrated to be effective under certain conditions. However, a hydrodynamic study would probably be required to evaluate the implementability and effectiveness of these technologies, particularly in the basin. The potential for reestablishing the biota community would have to be evaluated for the basin. In addition, enhanced or expedited sedimentation would probably require pilot-scale testing.

The other subgroup of technologies can be termed solidification/stabilization technologies and include the following:

Lime-Based Pozzolan	Pozzolan-Based Clay
Portland-Cement Pozzolan	Quicklime
Cement Overlay	Polymerization
Asphalt-based	Chemical Immobilization

These technologies involve some type of reaction with the contaminants that solidifies and/or stabilizes the waste in place. These technologies are proven and have been demonstrated to be effective under certain conditions. Treatability studies would be required. Bench-scale testing would be required to determine the proper additives and mix ratios. Pilot scale testing may also be require to evaluate the implementablity and effectiveness under in-situ conditions. The solidification/stabilization technologies may be more applicable to the ditches than the basin. The effect of these solidification/stabilization agents to the biota when introduced to the water column and the biozone of the basin would require investigation.

3.1.2 Thermal Treatment

Two potential in-situ thermal treatment technologies were identified, vitrification and radio-frequency treatment. The first technology, vitrification, is proven and has been demonstrated under certain conditions. However, the high water content and submerged sediments may make this technology unsuitable. Pilot scale treatability testing would probably be required.

The other technology, radio frequency treatment, is innovative and proposed to be effective at treating organics. However, it may be very limited in its effect on metals. This technology is not proven or demonstrated. Treatability testing would probably be required.

The heat generated by these thermal treatment technologies could be detrimental to the biota in the basin. These technologies are probably more applicable to the sediments in the ditches.

3.1.3 Chemical Treatment

Two in-situ chemical treatment technologies may be applicable to the sediments in OU-2. The first technology, reduction/oxidation, is potentially effective for organics and metals. The technology is proven and has been demonstrated under certain conditions. However, its effectiveness in-situ is questionable. Pilot-scale treatability testing would probably be required. A considerable amount of residual treatment would also be required by some other aspect of a treatment train.

The other technology, alkali metal dechlorination, would treat only the organic contaminants and not the metals. The technology, is proven and has been demonstrated effective on chlorinated organics. However, this technology is generally considered effective on filtered or dewatered material and may be unsuitable for in-situ treatment. Pilot-scale treatability testing would be required.

3.1.4 Physical Treatment

Two in-situ physical treatment technologies were identified. The first technology, vacuum steam/extraction, is potentially effective for the volatile organic constituents of concern, but is not effective on the semivolatiles or the metals. The use of steam to extract the organics may have adverse effects on the biota. The other technology, soil washing, is potentially effective for all groups of contaminants of concern if the constituents can be solubilized in a solvent that is not harmful to the biota of the basin. These technologies have been demonstrated under certain conditions. However, the inundated and submerged conditions of the bottoms of the ditch and basin and the low solubility and low vapor pressure of some of the organic compounds (e.g., hexachlorobenzene) may make these treatment technologies unsuitable. These technologies would probably require pilot-scale treatability testing.

3.1.5 Biological Treatment

Biodegradation of organic constituents has been proven and demonstrated. However, the metals present may have adverse effects in the process due to their toxic effects on the majority at microbes employed for organic biodegradation. Bench-scale and probably pilot-scale treatability testing would be required. This technology is not typically employed in a submerged environment which may make it unsuitable.

3.2 Direct Waste Treatment Technologies

The direct waste treatment technologies would require removal of the sediments either by excavation or dredging. Various methods of excavation or dredging exist and are fully demonstrated. As part of evaluating the removal methods, engineering controls may also require evaluation to determine the effects of removal on the aquatic system.

Following removal as discussed above, a treatment area would then be constructed, generally onsite, and the sediments would be transported to the treatment area. There are more treatment technologies available for direct treatment of wastes because there is more control over the application of the treatment (see Table 4). All of the following treatment technologies may be part of a treatment train that effectively treats the metals and organic constituents together or separately. Treatment of process water generated by these technologies will be discussed in Section 3.3.

3.2.1 Fixation/Encapsulation

The containment technologies, soil capping and multimedia capping described in Section 3.1.1., may be applicable to direct treatment if the base of the soil cover constructed on plant properly is adequately prepared. These proven and demonstrated technologies may be combined with any of the solidification/stabilization techniques described in Section 3.1.1 from the waste directly or as a result of other treatment technologies (chemical, physical, biological or thermal treatment). As mentioned in Section 3.1.1, the containment technologies would not require a treatability studies. The solidification/stabilization technologies would, probably require bench-scale treatability studies to determine the appropriate additives and mix ratios.

3.2.2 Thermal Treatment

The thermal treatment technology group can generally be categorized into three subgroups. These subgroups are combustion, pyrolysis and plasma arc. Combustion technologies are based on treatment in an ambient oxygen or oxygen-enriched environment utilizing high temperatures and turbulent flow. Pyrolysis technologies employ treatment in an oxygen-free or oxygen-deprived environment. Plasma arc technologies employ the use of a gas which has been energized into its plasma state.

The thermal treatment technologies generally do not require treatability testing, except vitrification. However, additional data would be required including heat value, chloride content, metal content and destruction efficiency.

The following treatment technologies are categorized as combustion technologies:

Fluidized Bed*
Circulating Bed Combustion*
Two State, Fluidized Bed/ Cyclonic Incinerator
Low Temperature Fluidized Bed*
Rotary Kiln*
Pyretron®*
Wet Air Oxidation
Supercritical Water Oxidation
Molten Salt*
Molten Glass

Turbulator*
Pedco Cascading*
Gasification
Thermocatalytic*
Catalytically Stabilized Thermal Combustor*
Linde® Oxygen Combustion*
Flame (Slagging) Reactor
Vaporization Extraction System
Submerged Quench
VEDA Solar

* May be effective on organic constituents of concern, but not metals.

The following treatment technologies are categorized as pyrolysis technologies:

Infrared*
Pyrolysis*
AOSTRA Taciuk*
Pyro-Disintegrator™
Electro Pyrolyzer

Vitrification**
Advanced Electric Reactor
Synthetica™ Detoxifier*
HT-5 Distillation*
Electric Melter Furnace

* May be effective on organic constituents of concern, but not metals.

** May be effective on organic constituents of concern and non-volatile metals, but not volatile metals.

The following treatment technologies are categorized as plasma arc technologies:

Plasma Torch*	Plasma Centrifugal*
Pyroplasma*	Al-Chem Detoxifier*

* May be effective on organic constituents of concern, but not metals.

3.2.3 Chemical Treatment

The chemical treatment technology group can generally be categorized into four subgroups. These subgroups are chemical extraction, dehalogenation, reduction/oxidation, and chelation. Chemical extraction technologies use chemical reagents to extract a constituent group from the waste mixture. Dehalogenation technologies employ chemical reagents to remove halogens, such as chlorine, from organic molecules. Reduction/oxidation technologies change the oxidation state of two constituent groups oppositely in concert availing the constituents to some further treatment. Chelation technologies bind a molecule and generally remove it from a waste mixture by precipitation.

Treatability testing would probably be required for the chemical treatment technologies. The treatability testing would probably be a combination of bench-scale and pilot-scale testing.

The following treatment technologies are categorized as chemical extraction technologies:

BEST® (Basic Extraction Sludge Treatment)	Liquified Gas*

* May be effective on organic constituents of concern, but not metals.

The following treatment technologies are categorized as dehalogenation technologies:

Alkali Metal Dechlorination*	APEG*
Catalytic Dechlorination*	APEG-PLUS®*

* May be effective on organic constituents of concern, but not metals.

The following treatment technologies are categorized as reduction/oxidation technologies:

Reduction/Oxidation	Chemical Hydrolysis
Electrolytic Oxidation**	

** May be effective on metals of concern, but not organic constituents.

The chelation technology is effective only on metals of concern, but not the organic constituents.

3.2.4 Physical Treatment

The physical treatment technologies group can generally be categorized into three subgroups. These subgroups are physical extraction, flotation and aeration. Physical extraction technologies employ the use of physical methods, such as manipulation of pressure, temperature, handling of material, density differences. Flotation technologies employ the use of physical agents to remove the constituent of concern from a waste mixture. Aeration technologies use air currents to strip the constituents of concern from the waste mixture.

Bench-scale treatability testing would probably be required for all physical treatment technologies. Pilot-scale testing could be required based on the results of the bench-scale testing.

The following treatment technologies are categorized as physical extraction technologies:

Supercritical Fluid Extraction*	Heavy Media Separation
LEEP (Low Energy Extraction Procedure)*	Soil Washing

* May be effective on organic constituents of concern, but not metals.

The following treatment technologies are categorized as aeration technologies:

Aeration*	Low Temperature Thermal Stripping*
Mechanical Aeration/Extraction*	

* May be effective on volatile organic constituents, but not the semivolatile organic constituents and metals of concern.

The following treatment technologies are categorized as flotation technologies:

Frot Flotation*	Froth Flotation with Solvent Extraction*

* May be effective only on organic constituents of concern, but not metals.

3.2.5 Biological Treatment

The biological treatment technology group can generally be categorized into four subgroups. These subgroups are aerobic bacterial, anaerobic bacterial, algal and mycological. Aerobic bacterial technologies employ bacteria to metabolize and degrade the waste through oxidation which uses oxygen as the final electron acceptor. Anaerobic bacterial technologies employ bacteria to metabolize and degrade the waste through reduction in the absence of oxygen utilizing sulfur usually as the final electron acceptor. Algal technologies utilize algae species to degrade the waste. Mycological technologies employ fungi species to degrade the waste.

Biological treatment technologies are generally very specific to the matrix and the chemicals to be treated. Treatability testing would be required and the testing would probably include a combination of bench and pilot-scale tests.

The following treatment technologies are categorized as aerobic bacterial technologies:

Aerobic Respiration*	Solid Phase*
Composting*	Gas Permeable Membranes*
Slurry-Phase* (can be used anaerobically, also)	Toxigon™*

* May be effective on organic constituents of concern, but not metals.

The following treatment technologies are categorized as anaerobic bacterial technologies:

Anaerobic Respiration*	Slurry-Phase* (can be used aerobically, also)

* May be effective on organic constituents of concern, but not metals.

The identified algal technology (Alga SORB®) is potentially effective on metals of concern but not the organic constituents. The only identified mycological technology (white rot fungus) is potentially effective on organic constituents of concern, but not metals.

3.3 Process Water Treatment Technologies

Some of the aforementioned treatment technologies, particularly chemical treatment, will generate process water that may require further treatment. The following treatment technologies are identified for treating this process water (Table 5).

3.3.1 Thermal Treatment

All thermal treatment technology groups listed in Section 3.2.2 are applicable for the produced process water.

3.3.2 Chemical Treatment

The chemical treatment technology group for possible process water can generally be categorized into five subgroups. These subgroups are reduction/oxidation, adsorption, precipitation, reverse osmosis and electrodialysis. Reduction/oxidation technologies employ the adjustment of oxidation states of two species oppositely in concert to make them more susceptible to removal from the waste matrix. Adsorption technologies use molecules that have adsorptive properties to remove the constituents of concern. Precipitation technology adjusts the pH to a point where the constituent of concern has its lowest solubility. Reverse osmosis technology uses pressure to move solute to a more concentrated area thereby reducing volume for further treatment. Electrodialysis technology separates ionic species based on their electric state.

Treatability testing would generally be required for the chemical treatment technologies. The treatability testing is generally simple bench-scale test conducted by vendors. In some cases, such as with granular activated carbon, the evaluation may be conducted using the water chemistry data without treatability testing.

The following treatment technologies are categorized as reduction/oxidation technologies:

Ozonation	Ion Exchange*
Oxidation by Hypochlorite	Ultraviolet Photolysis*
Oxidation by Hydrogen Peroxide	Solar-Driven Photocatalytic*
	Neutralization

* May be effective on organic constituents of concern, but not metals.

The following treatment technologies are categorized as adsorption technologies:

Granular Activated Carbon (G.A.C.) Adsorption	Resin Adsorption

Precipitation, reverse osmosis and electrodialysis technologies are potentially effective for both the organics and the metals.

3.3.3 Physical Treatment

The physical treatment technology group can generally be categorized into five subgroups. These subgroups are sedimentation/flotation, filtration, membrane permeation, stripping and distillation. Sedimentation/flotation technologies separate suspended solids from the waste by causing it to drop out or move to the top of a reaction vessel and removed. Filtration technologies employ a porous medium for the removal of suspended solids. Membrane permeation technologies use semi-permeable membranes for the separation of constituents from water reducing volume for further treatment. Stripping technologies utilize air currents to remove organic constituents, particularly volatiles, from a waste matrix. Distillation technology uses evaporation and condensation to separate organic and inorganic constituents, particularly volatiles, from a waste matrix.

The physical treatment technologies would generally be used in combination with other technologies. Bench-scale treatability testing would generally be required except for the filtration technologies. Also, air stripping and steam stripping can commonly be evaluated without treatability testing. The need for treatability testing of the water treatment processes will generally be dependent on the data obtained from the treatability test from the associated sediment treatment technology.

The following treatment technologies are categorized as sedimentation/flotation technologies:

Sedimentation	Flocculation
Dissolved Air Flotation	Induced Air Flotation

The following treatment technologies are categorized as filtration technologies:

Filtration

Micellar-Enhanced Ultrafiltration

The following treatment technologies are categorized as membrane permeation technologies:

Emulsion Liquid Membrane Separation*

Composite Membranes*

* May be effective on organic constituents of concern, but not metals.

The following treatment technologies are categorized as stripping technologies:

Air Stripping*

Steam Stripping*

* May be effective on volatile organics but not the semi-volatile organic constituents of concern or metals.

Distillation may be effective for volatile organics and volatile metals but not the semi-volatile organic constituents of concern or non-volatile metals.

3.3.4 Biological Treatment

The previously listed direct waste biological treatment technologies are applicable to process water with the exception of the aerobic bacterial technologies of composting and solid-phase. Three additional aerobic bacterial technologies are applicable to aqueous matrices.

Each technology would require bench or pilot-scale treatability studies.

The additional aerobic bacterial technologies are:

Activated Sludge*	Heavy Metal Removal**
Rotating Biological Contactor*	

* May be effective on organic constituents of concern, but not metals.

** May be effective on metals of concern, but organic constituents.

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TABLES

TABLE 1

CHEMICALS OF POTENTIAL CONCERN[1]
OPERABLE UNIT 2

Sediment	Surface Water
Arsenic	Alpha-BHC
Benzene[2]	Arsenic
Chromium	Cadmium
Hexachlorobenzene	Cyanide
Mercury	Chromium
	Mercury
	Nickel
	Zinc

NOTES:

1 The chemicals of potential concern are those that contribute greater than 1 percent of the total carcinogenic or non-carcinogenic hazard based on the maximum concentrations reported for the media and a concentration-toxicity screening. The Hazardous Substance Indicator Parameter Technical Memorandum (HSIPTM) submitted to EPA on December 19, 1991 provides the procedures for calculating the relative hazard for each constituent. The list has been revised since submittal of the HSIPTM based on the validated data and EPA comments.

2 Benzene does not contribute greater than 1 percent of the total carcinogenic or non-carcinogenic risk based on the concentration-toxicity screening. However, it is included on the chemicals of potential concern list because of its Class A carcinogen status.

TABLE 2

REVISED REMEDIAL ACTION OBJECTIVES
OPERABLE UNIT 2

Media	Preliminary Remediation Goal		Potential ARARs[1]	
	Human Health	Environmental Protection	Chemical Specific	Location Specific
Sediment	Prevent direct contact with sediments having contaminant concentrations with a cumulative cancer risk in excess of 1×10^{-4} to 1×10^{-6} or a cumulative Hazard Index greater than 1.	Prevent contaminant releases from sediments that cause exceedences of surface water remediation goals or exceedences of fish and game health-based standards or action levels.	None Identified	• Executive Orders related to floodplains and wetlands • Section 404 of the Clean Water Act • Rivers and Harbors Act of 1899 • RCRA Corrective Action Program
Surface Water	Prevent ingestion/direct contact with surface water having contaminant concentrations with a cumulative cancer risk in excess of 1×10^{-4} to 1×10^{-6} or a Hazard Index greater than 1.	Prevent contamination in excess of surface water remediation goals. Prevent contaminant releases from surface water that cause exceedances of fish and game health-based standards or action levels.	• Clean Water Act and NPDES Discharge Limits • State of Alabama Rules	• Executive Orders related to floodplains and wetlands • Rivers and Harbors Act of 1899 • Section 404 of the Clean Water Act
Fish and Game	Prevent ingestion of fish and game having contaminant concentrations with a cumulative cancer risk in excess of 1×10^{-4} to 1×10^{-6} or a cumulative Hazard Index greater than 1.	Prevent ingestion of contaminated fish and game by higher trophic levels causing these higher trophic levels to exceed fish and game health-based standards or action levels.	None Identified	• Endangered Species Act of 1973 • Fish and Wildlife Coordination Act • Fish and Wildlife Improvement Act of 1978 • Fish and Wildlife Conservation Act of 1980 • Rivers and Harbors Act of 1899

NOTE: [1] For regulatory citations, refer to the Revised Remedial Action Objectives Technical Memorandum.

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TABLE 3

POTENTIALLY APPLICABLE IN SITU TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Fixation/Encapsulation				
Containment				
Soil Capping	X	X	Involves the placement of imported sediment over existing sediments by pumping from a barge or dredge through a diffuser head over the sediment.	May require a hydrodynamic investigation to evaluate the feasibility of placing the material and the potential for erosion.
Multimedia Capping	X	X	Provides for a submerged cover system consisting of a geotextile, Fabriform® liner, crushed aggregate and cover soil.	(Same as above)
Backfilling	X	X	A form of containment that consists of covering the sediments to an above-grade elevation.	(Same as above)
Natural Sedimentation	X	X	Consists of allowing the natural processes within the water body to continue depositing new sediments long-term and monitoring of the sedimentation process with respect to fish, water and sediments.	Would require a more detailed evaluation of the hydrodynamics of the basin including sedimentation rates and evaluation of sediment transport at different water elevations in the basin and the adjacent Tombigbee River.
Enhanced Sedimentation	X	X	Structures such as gabion blocks or similar materials or an earthen dam which can be placed in submerged conditions serve to impede the movement of water and thereby trap sediments to enhance the natural sedimentation process.	In addition to the hydrodynamic evaluation described above, pilot-scale testing would probably be required.

TABLE 3 (Continued)

POTENTIALLY APPLICABLE IN SITU TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To			
	Metals	Organics	Description	Additional Data Requirements
Expedited Sedimentation	X	X	Consists of providing a means of accelerating sedimentation by reworking the water body banks. The bank is scarified and a geotextile is placed and covered with erodible soils to expedite the sedimentation process.	In addition to the hydrodynamic evaluation described above, pilot-scale testing would probably be required.
Solidification/Stabilization				
Lime-Based Pozzolan	X	X	Addition of siliceous materials combined with a settling agent such as lime, cement or gypsum.	Initially would require bench-scale testing to determine the appropriate additives and mix ratios. May also require pilot-scale testing to evaluate applicability to in-situ conditions.
Portland Cement Pozzolan	X	X	Mixes waste with cement to incorporate the waste into the cement matrices.	(Same as above)
Cement Overlay	X	X	Portland cement pozzolanic reaction at interface, then overlay with concrete to line ditch.	(Same as above)
Asphalt-Based	X	X	Mixing of heated dried waste within an asphalt bitumen, paraffin or polyethylene matrix.	(Same as above)
Pozzolan-Based Clay		X	Utilizes a pozzolanic-based product containing clay.	(Same as above)
Quicklime		X	Utilizes CaOH mixed with the contaminated material.	(Same as above)
Polymerization		X	Catalysts convert monomers to polymers which often have greater stability.	(Same as above)

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TABLE 3 (Continued)

POTENTIALLY APPLICABLE IN SITU TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Chemical Immobilization	X	X	Metals stabilized as insoluble precipitate, certain organic monomers can be stabilized as polymers.	Initially would require bench-scale testing to determine the appropriate additives and mix ratios. May also require pilot-scale testing to evaluate applicability to in-situ conditions.
Thermal Treatment				
Vitrification	X	X	Destruction of organics. Immobilization of metals.	Initially would require bench-scale testing to determine effectiveness for matrix and chemicals of concern. May also require pilot-scale testing to evaluate applicability to in-situ conditions.
Radio Frequency		X	Organics are destroyed or mobilized by vaporization, thermal decomposition, or distillation.	(Same as above)
Chemical Treatment				
Reduction/Oxidation	X	X	Reduces or oxidizes most organics and certain metals. Considerable amount of residuals treatment is required.	Bench-scale or pilot-scale treatability testing would probably be required.
Alkali Metal Dechlorination		X	Dechlorination of organics by affinity for alkali metals on filtered or dewatered material.	(Same as above)
Physical Treatment				
Vacuum/Steam Extraction		X	Recover organics for further treatment or disposal with Henry's constant >0.001 atm·m^3/mole.	(Same as above)

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TABLE 3 (Continued)

POTENTIALLY APPLICABLE IN SITU TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Soil Washing/Flushing	X	X	Requires solubility of contaminants in a solvent to flush contaminants from subsurface strata.	Bench-scale or pilot-scale treatability testing would probably be required.
Biological Treatment				
Biodegradation		X	Utilizes bacteria for the degradation of organics, often used in conjunction with a groundwater pumping system.	Bench-scale treatability testing would probably be required. Pilot-scale treatability testing may be performed as an extension of bench-scale studies.

Applicable to:

X = Technology is applicable to indicated chemical group

TABLE 4

POTENTIALLY APPLICABLE DIRECT WASTE TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Fixation/Encapsulation				
The containment alternatives of soil capping and multimedia capping and the aforementioned solidification/stabilization alternatives with the exception of cement overlay are applicable as a direct waste treatment technology.				See comments in Fixation/Encapsulation section of Table 3. Pilot-scale testing would probably not be required for fixation/encapsulation as direct waste treatment technologies.
Thermal Treatment				
Combustion				
Fluidized Bed	-	X	Consists of a bed of inert, granular, sand-like material, combustion air is forced upward through the bed, which fluidizes the material at a minimum critical velocity.	Thermal destruction technologies generally do not require treatability testing. However, parameters such as heat value, chlorine content, metal content and destruction efficiency may be required.
Circulating Bed Combustion		X	Variation of fluidized bed, uses higher air velocity and circulating solids to create a larger and highly turbulent combustion zone.	(Same as above)
Two Stage, Fluidized Bed/Cyclonic Incinerator	X	X	Combine fluidized bed with cyclonic combustion. Inorganic contaminants will be encapsulated in glassy leach-resistant agglomerates.	(Same as above)

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TABLE 4 (Continued)

POTENTIALLY APPLICABLE DIRECT WASTE TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Low Temperature Fluidized Bed		X	Eliminates the use of refractory materials in combustion chamber that requires periodic replacement. Air and nitrogen are used to fluidize the carbonate/catalyst bed.	Thermal destruction technologies generally do not require treatability testing. However, parameters such as heat value, chlorine content, metal content and destruction efficiency may be required.
Rotary Kiln		X	Involves the controlled combustion of organic wastes under net oxidizing conditions.	(Same as above)
Pyretron® (Rotary Kiln)		X	Combustion central system that uses oxygen or oxygen-enriched air to improve process control while significantly increasing incineration throughput.	(Same as above)
Wet Air Oxidation	-	X	Breaks down suspended and dissolved oxidizable inorganic and organic materials by oxidation in a high-temperature, high-pressure, aqueous environment.	(Same as above)
Supercritical Water Oxidation	X	X	The process is based on the ability of water to perform as an excellent solvent for organics when it is above its critical temperature (705°F) and pressure (3,200 psi). Inorganic salts become insoluble above 930°F, and precipitate.	(Same as above)

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TABLE 4 (Continued)

POTENTIALLY APPLICABLE DIRECT WASTE TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Molten Salt		X	A method of burning organic material while, at the same time, sorbing objectionable by-products of combustion from the effluent gas stream.	Thermal destruction technologies generally do not require treatability testing. However, parameters such as heat value, chlorine content, metal content and destruction efficiency may be required.
Molten Glass	X	X	Uses a pool of molten glass as the heat transfer mechanism. Ash and inorganic residue are captured in the glass.	(Same as above)
Turbulator		X	High-turbulence combustion system designed to handle liquid wastes.	(Same as above)
Pedco Cascading		X	Able to handle viscous and high-solids-content wastes, originally developed for destruction of low-Btu hazardous wastes, has been adopted to allow for energy recovery as well.	(Same as above)
Gasification	X	X	Hydrocarbon gasification process to produce synthesis gas for use in chemical production and power generation. Waste material is suitable if slurried, high enough energy content, slagging temperature of ash is sustained.	(Same as above)
Thermocatalytic		X	Catalytic, thermochemical process that converts aqueous organic wastes into a medium-Btu gas consisting mainly of methane and carbon dioxide.	(Same as above)

TABLE 4 (Continued)

POTENTIALLY APPLICABLE DIRECT WASTE TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Catalytically Stabilized Thermal Combustor		X	Using a hot-walled tubular reactor and catalytic surface reactions, the combustor stabilizes gas-phase combustion in a near plug-flow pattern.	Thermal destruction technologies generally do not require treatability testing. However, parameters such as heat value, chlorine content, metal content and destruction efficiency may be required.
Linde® Oxygen Combustion		X	Increase throughput of conventional incinerators, uses a patented burner, flow-control piping, a control console and is designed to use up to 100 percent oxygen.	(Same as above)
Flame (Slagging) Reactor	X	X	A hydrocarbon-fueled, flash smelting system produces a decontaminated molten slag and a recyclable, heavy metal-enriched oxide.	(Same as above)
Vaporization Extraction System	X	X	Materials are mixed with hot gas in a co-current, stirred fluidized bed.	(Same as above)
Submerged Quench	X	X	Chamber is a vertical cylinder which allows removal of large amounts of material continuously. The outlet of the chamber into a submerged quench system.	(Same as above)
VEDA Solar		X	An array of sun-tracking mirrors concentrate and reflect the sun's radiant energy to a windowed reactor vessel to destroy hazardous organic wastes.	(Same as above)

TABLE 4 (Continued)

POTENTIALLY APPLICABLE DIRECT WASTE TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Pyrolysis				
Infrared		X	Uses silicon carbide elements to generate thermal radiation beyond the red end of the visible spectrum.	Thermal destruction technologies generally do not require treatability testing. However, parameters such as heat value, chlorine content, metal content and destruction efficiency may be required.
Pyrolysis		X	Destruction of organic material in the absence of oxygen at a high temperature.	(Same as above)
AOSTRA Taciuk		X	Separates and recovers hydrocarbon from soil or inert solids.	(Same as above)
Pyro-Disintegrator™	X	X	Wastes are dewatered as an electric current is passed through a waste/flocculent mixture during pressure filtration. Residual solids enter an electric furnace where organics are destroyed and inorganic constituents are encapsulated.	(Same as above)
Electric Pyrolyzer	X	X	Uses electrical energy to generate temperatures near 3,000°F in a low-oxygen or oxygen-free environment. Organics are pyrolyzed and inorganics are melted to form a glass-like residue.	(Same as above)
Vitrification	NV	X	Used to transform chemical and physical characteristics of hazardous waste such that the treated residues contain hazardous material immobilized in a vitreous mass.	Initially would require bench-scale testing to determine effectiveness for nature and chemicals of concern. May also require pilot-scale testing to evalaute applicability to direct waste treatment conditions.

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TABLE 4 (Continued)

POTENTIALLY APPLICABLE DIRECT WASTE TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Advanced Electric Reactor	X	X	Uses electrically heated fluid walls to pyrolyze waste. Inorganic compounds melt and are fused into vitreous solids.	Thermal destruction technologies generally do not require treatability testing. However, parameters such as heat value, chlorine content, metal content and destruction efficiency may be required.
Synthetica™ Detoxifier		X	Wastes are destroyed in the unit by a proprietary steam gasification process that uses electrical energy rather than open-flame combustion.	(Same as above)
HT-5 Distillation		X	Heats water in a nitrogen atmosphere to vaporize volatile and semivolatile compounds. Dry, granular solids generated during the process are inert.	(Same as above)
Electric Melter Furnace	X	X	A high-temperature, non-flame furnace used for the production of glass from liquid or solid feeds with the addition of silicates.	(Same as above)
Plasma Arc Torch				
Plasma Torch		X	Functions by contacting the waste feed with a gas which has been energized into its plasma state by an electrical discharge.	(Same as above)
Pyroplasma		X	A plasma arc torch that operates at extremely high temperatures.	(Same as above)

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TABLE 4 (Continued)

POTENTIALLY APPLICABLE DIRECT WASTE TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Plasma Centrifugal		X	Uses a plasma torch to melt solids, destroy contaminants and produce a vitrified residue using a 6-foot-diameter reactor tub.	Thermal destruction technologies generally do not require treatability testing. However, parameters such as heat value, chlorine content, metal content and destruction efficiency may be required.
Al-Chem Detoxifier		X	Use electrically generated plasma to gasify and pyrolyze wastes where the plasma zone occurs at a submerged oil-water interface.	(Same as above)
Chemical Treatment				
Chemical Extraction				
BEST® (Basic Extraction Sludge Treatment)		X	A secondary or tertiary amine is mixed at cool temperatures with soils or sludges, used primarily to treat oily sludges containing hydrocarbons and other high-molecular weight organics.	Bench-scale or pilot-scale treatability testing would probably be required.
Liquified Gas		X	Carbon dioxide and propane at high pressure are used to extract oils and organic solvents from sludge in a continuous process.	(Same as above)
Dehalogenation				
Alkali Metal Dechlorination		X	Dechlorination of organics by affinity for alkali metals on filtered or dewatered material.	(Same as above)

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TABLE 4 (Continued)

POTENTIALLY APPLICABLE DIRECT WASTE TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Catalytic Dechlorination		X	Based on the reaction of polychlorinated hydrocarbons with high pressure hydrogen gas in the presence at a catalyst. The feed must be either liquid or gaseous form with the inorganic and inert constituents removed.	Bench-scale or pilot-scale treatability testing would probably be required.
APEG		X	Alkali metals and polyethylene glycols react rapidly to dehalogenate halo-organic compounds of all types.	(Same as above)
APEG-PLUS®		X	Same as above, plus the use of specifically potassium hydroxide and dimethyl sulfoxide to aid dehalogenation. Slurry is transferred to centrifuge to recover/recycle reagents.	(Same as above)
Reduction/Oxidation				
Reduction/Oxidation	X	X	Process is employed to destroy hazardous components or convert the hazardous components to less hazardous forms by raising the oxidation state of one reactant and lowering that of another.	(Same as above)
Electrolytic Oxidation	X		Cathodes and oxides are immersed in a tank containing a waste to be oxidized. Metals will plate on the cathodes when an electric current is imposed.	(Same as above)

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TABLE 4 (Continued)

POTENTIALLY APPLICABLE DIRECT WASTE TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Chemical Hydrolysis	X	X	Process of breaking a bond in a molecule so that it will go into ionic solution by the addition of chemicals, by irradiation or biologically. The cloven molecule can be further treated by other means to reduce toxicity.	Bench-scale or pilot-scale treatability testing would probably be required.
Chelation				
Chelation	X		A chelating molecule is used to form ligands with metal ions and make it usable to form ionic salts which can precipitate. Used to keep metals in solution and to aid in dissolution for subsequent transport and removal.	(Same as above)
Physical Treatment				
Physical Extraction				
Soil Washing/Flushing	X	X	Process extracts contaminants from sludge or soil matrices using a liquid medium as the washing fluid. The washing fluid may be composed of water, organic solvents, water/chelating agents, water/surfactants, acids or bases, depending on the contaminant to be removed.	(Same as above)

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TABLE 4 (Continued)

POTENTIALLY APPLICABLE DIRECT WASTE TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Supercritical Fluid Extraction		X	At certain temperature and pressure, fluids reach their critical point, beyond which their solvent properties are greatly enhanced. Carbon dioxide is used to extract hazardous organics from aqueous streams.	Bench-scale or pilot-scale treatability testing would probably be required.
LEEP (Low Energy Extraction Procedure)		X	Designed to remove organics from contaminated soil and sediment. Process produces decontaminated solid and water effluents and concentrates the contaminants in a small-volume solvent stream that can either be recycled or incinerated.	(Same as above)
Heavy Media Separation	X	X	Process for separating two solid materials which have significantly different absolute densities. Solids are placed in a fluid with a specific gravity so that the lighter solid floats while the heavier sinks.	(Same as above)
Centrifugation	X	X	Process in which the components of a fluid mixture are separated mechanically based on their relative density by rapidly rotating the fluid mixture within a rigid vessel.	(Same as above)
Aeration				
Aeration		V	Process involves the use of a vibratory screening and aeration system. Soil is passed over a series of screens with countercurrent air to promote volatilization.	(Same as above)

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TABLE 4 (Continued)

POTENTIALLY APPLICABLE DIRECT WASTE TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Mechanical Aeration/Extraction		V	Entails contacting clean air with the contaminated soils in order to transfer the volatile organics from the soil into the air stream for further treatment.	Bench-scale or pilot-scale treatability testing would probably be required.
Low Temperature Thermal Stripping		V	The design processes contaminated soils through a pug mill or rotary drum system equipped with heat transfer surface. Generally used to remove volatile organics with a Henry's Law constant of at least 0.003 atm $\cdot$ m^3/mole from soils or similar solids.	(Same as above)
Sedimentation/Flotation				
Froth Flotation		X	Process scours contaminants from the surface of sand and larger particles and also concentrates the clay/silt fraction thereby reducing volume for further treatment.	(Same as above)
Froth Flotation and Solvent Extraction		X	Same as above with the addition of a mixture of polar and nonpolar solvents in three, countercurrent mixing stages designed to minimize the loss of solvent.	(Same as above)
Biological Treatment				
Aerobic Bacterial				
Aerobic Respiration		X	Organic molecules are oxidized to carbon monoxide and water and other end products using molecular oxygen as the terminal electron acceptor.	Bench-scale treatability testing would probably be required. Pilot-scale treatability testing may be performed as an extension of bench-scale studies.

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TABLE 4 (Continued)

POTENTIALLY APPLICABLE DIRECT WASTE TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	**Organics**		
Composting		X	Storage of highly biodegradable and structurally firm material with a small percentage of biodegradable waste.	Bench-scale treatability testing would probably be required. Pilot-scale treatability testing may be performed as an extension of bench-scale studies.
Slurry-Phase (*also has anaerobic bacterial application*)		X	Involves the treatment of contaminated soil or sludge in a large mobile bioreactor which maintains intimate mixing and contact of micro-organisms with the hazardous compounds.	(Same as above)
Solid-Phase		X	Process that treats soils in an above grade system using conventional soil management practices to enhance the microbial degradation of contaminants.	(Same as above)
Gas-Permeable Membranes		X	Provide bacterial cultures with a support base as well as a means of acquiring oxygen required for survival.	(Same as above)
Toxigon™		X	Designed to enhance the degradation of specific contaminants and to accelerate remediation using an emulsifier, a natural blend and a series of dehydrated microbes.	(Same as above)
<u>Anaerobic Bacterial</u>				
Anaerobic Respiration		X	Process achieves the reduction of organic matter, in an oxygen-free environment, to methane and carbon dioxide using facultative and obligate anaerobes.	(Same as above)

TABLE 4 (Continued)

POTENTIALLY APPLICABLE DIRECT WASTE TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Algal				
Alga SORB®	X		The process is based on an algae species that has a very large number of bonding sites for heavy metals that differ in affinity and specificity.	Bench-scale treatability testing would probably be required. Pilot-scale treatability testing may be performed as an extension of bench-scale studies.
Mycological				
White-Rot Fungus		X	The lignin degrading white-rot fungus has been found to degrade a broad spectrum of organopollutants including chlorinated, aliphatic, aromatic-heterocyclic compounds.	(Same as above)

X = Technology is applicable to indicated chemical group
NV = Only applicable to non-volatile fraction of chemical group
V = Only applicable to volatile fraction of chemical group

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TABLE 5

POTENTIALLY APPLICABLE PROCESS WATER TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Thermal Treatment				
All previous direct waste thermal treatment technologies previously listed are applicable				Thermal destruction technologies generally do not require treatability testing. However, prameters such as heat value, chlorine content, metal content and destruction efficiency may be required.
Chemical Treatment				
Reduction/Oxidation				
Ozonation	X	X	A chemical oxidation process appropriate for aqueous streams which contain less than 1 percent oxidizable compounds.	Bench-scale or pilot-scale treatability testing would probably be required.
Oxidation by Hypochlorite	X	X	Process consists of adding sodium or calcium hypochlorite to oxidize organic wastes.	(Same as above)
Oxidation by Hydrogen Peroxide	X	X	Based on the addition of hydrogen peroxide, an excellent oxidizing agent, to oxidize organic compounds.	(Same as above)
Ion Exchange	X		Process is usually based on the use of specifically formulated resins having an "exchangeable" ion bound to the resin with a "weak ionic" band.	(Same as above)
Ultraviolet Photolysis		X	A process that destroys or detoxifies hazardous chemicals in aqueous solutions utilizing UV irradiation.	(Same as above)

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TABLE 5 (Continued)

POTENTIALLY APPLICABLE PROCESS WATER TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Solar-Driven Photocatalytic		X	Ultraviolet energy activates sites on the catalyst surface (titanium dioxide), causing the formation of reactive species which initiate further reaction that result in the complete oxidation and mineralization of the organic contaminants.	Bench-scale or pilot-scale treatability testing would probably be required.
Neutralization	X	X	Used to treat waste organic or inorganic wastestreams in order to reduce or eliminate their reactivity and corrosiveness.	(Same as above)
Adsorption				
Granular Activated Carbon (G.A.C.) Adsorption	X	X	Water is passed through a pressure vessel that contains granular activated carbon. Most organics, and many inorganics, will readily attach themselves to the carbon.	Technology can commonly be evaluated without treatability testing based on the water chemistry.
Resin Adsorption	X	X	Removes organic and inorganic constituents, regenerated in place with a liquid regenerant, producing a more concentrated spent regenerant stream which requires further treatment.	Bench-scale or pilot-scale treatability testing would probably be required.
Precipitation				
Precipitation	X	X	Acid or base is added to a solution to adjust the pH to a point where the constituents to be removed have their lowest solubility.	(Same as above)

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TABLE 5 (Continued)

POTENTIALLY APPLICABLE PROCESS WATER TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To: Metals	Applicable To: Organics	Description	Additional Data Requirements
Osmosis				
Reverse Osmosis	X	X	Application of high pressure will cause flow of solvent across a semipermeable membrane from a more dilute concentration to a more concentrated state thereby reducing the volume of organic and inorganic contaminants for further treatment.	Bench-scale or pilot-scale treatability testing would probably be required.
Electrodialysis				
Electrodialysis	X	X	Concentrates or separates ionic species by passing a water solution through alternately placed cation-permeable and anion-permeable membranes.	(Same as above)
Physical Treatment				
Aeration				
Air Stripping		V	A mass transfer process in which volatile contaminants in water or soils are evaporated into the air.	Technology can commonly be evaluated without treatability testing.
Steam Stripping		V	A continuous fractional distillation process carried out in a packed or tray tower that evaporates volatile organics from aqueous wastes.	(Same as above)
Sedimentation/Flotation				
Sedimentation	X	X	A gravity settling process which allows heavier solids to collect at the bottom of a containment vessel resulting in its separation from the suspending fluid.	Bench-scale or pilot-scale treatability testing would probably be required.

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TABLE 5 (Continued)

POTENTIALLY APPLICABLE PROCESS WATER TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Flocculation	X	X	Used to enhance sedimentation or centrifugation. Flocculants adhere readily to suspended solids and with each other so that the resultant particles are too large to remain in suspension.	Bench-scale or pilot-scale treatability testing would probably be required.
Dissolved Air Flotation (pressurized) or Induced Air Flotation (at atmospheric pressure)	X	X	Process whereby suspended particles or mixed liquids can be removed from an aqueous waste stream by saturation with air. As air comes out of solution, microbubbles form which can readily absorb to particles enhancing their flotation characteristics.	(Same as above)
Filtration				
Filtration	X	X	A process of separating and removing suspended solids from a liquid by passing the liquid through a porous medium.	Bench-scale or pilot-scale treatability testing would generally not be required.
Micellar-Enhanced Ultrafiltration	X	X	The addition of surfactants to wastewaters enhance ultrafiltration and is applicable to wastewater containing lower molecular weight (<300 m.w.) organics and heavy metals.	(Same as above)
Granular Media Filtration	X	X	Uses gravity to remove solids from a fluid by passage through a bed of granular material.	(Same as above)

TABLE 5 (Continued)

POTENTIALLY APPLICABLE PROCESS WATER TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Membrane Permeation				
Emulsion Liquid Membrane Separation		X	Process concentrates contaminants into a reduced-volume product stream for disposal or recycling. Current research is focusing on the treatment of wastewaters containing low concentrations of phenols.	Bench-scale or pilot-scale treatability testing would probably be required.
Composite Membranes		X	Technology utilities composite semi-permeable membranes that are more permeable to organics than to water.	(Same as above)
Distillation				
Distillation	X	X	Process of evaporation followed by condensation whereby separation of volatile materials can be optionized by controlling the evaporation stage temperature and pressure and the condense temperature.	(Same as above)
Biological Processes				
All direct waste biological treatment technologies previously listed apply to an aqueous matrix with the exception of composting and solid-phase.				Bench-scale treatability testing would probably be required. Pilot-scale treatability testing may be performed as an extension of bench scale studies.
Aerobic Bacterial				
Activated Sludge		X	Breaks down organic contaminants in aqueous waste streams through the activity of aerobic microorganisms which metabolize biodegradable organics.	(Same as above)

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TABLE 5 (Continued)

POTENTIALLY APPLICABLE PROCESS WATER TREATMENT TECHNOLOGIES
OLIN MCINTOSH SITE
MCINTOSH, ALABAMA

	Applicable To		Description	Additional Data Requirements
	Metals	Organics		
Rotating Biological Contactor		X	Process consists of primary treatment for solids removal followed by the contactors where the waste stream comes into contact with the microbial film and the atmosphere.	Bench-scale treatability testing would probably be required. Pilot-scale treatability testing may be performed as an extension of bench scale studies.
Anaerobic Bacterial				
Heavy Metal Removal	X		Spore form of bacteria has the ability to remove heavy metals from contaminated wastewaters. Removal mechanisms include adsorption, bioaccumulation, metal reduction and conversion to insoluble metal sulfides.	(Same as above)

X = Technology is applicable to indicated chemical group
V = Only applicable to volatile fraction of chemical group

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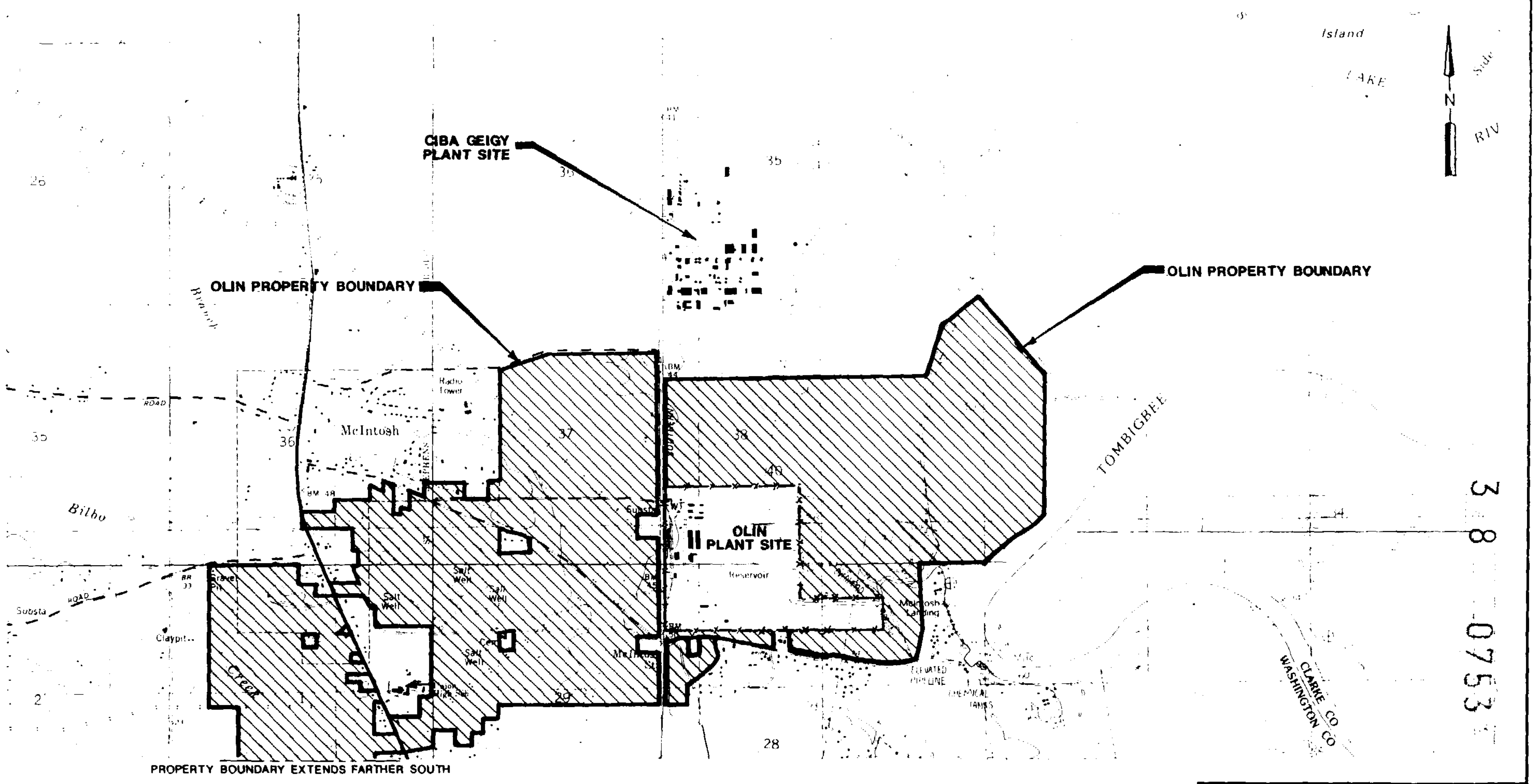
FIGURES



LEGEND

—x— OLIN PLANT SITE FENCE LINE

OLIN PROPERTY BEYOND PLANT SITE

ALABAMA

QUADRANGLE LOCATION

0 (FEET) 2000
SCALE

RI/FS
McINTOSH PLANT SITE

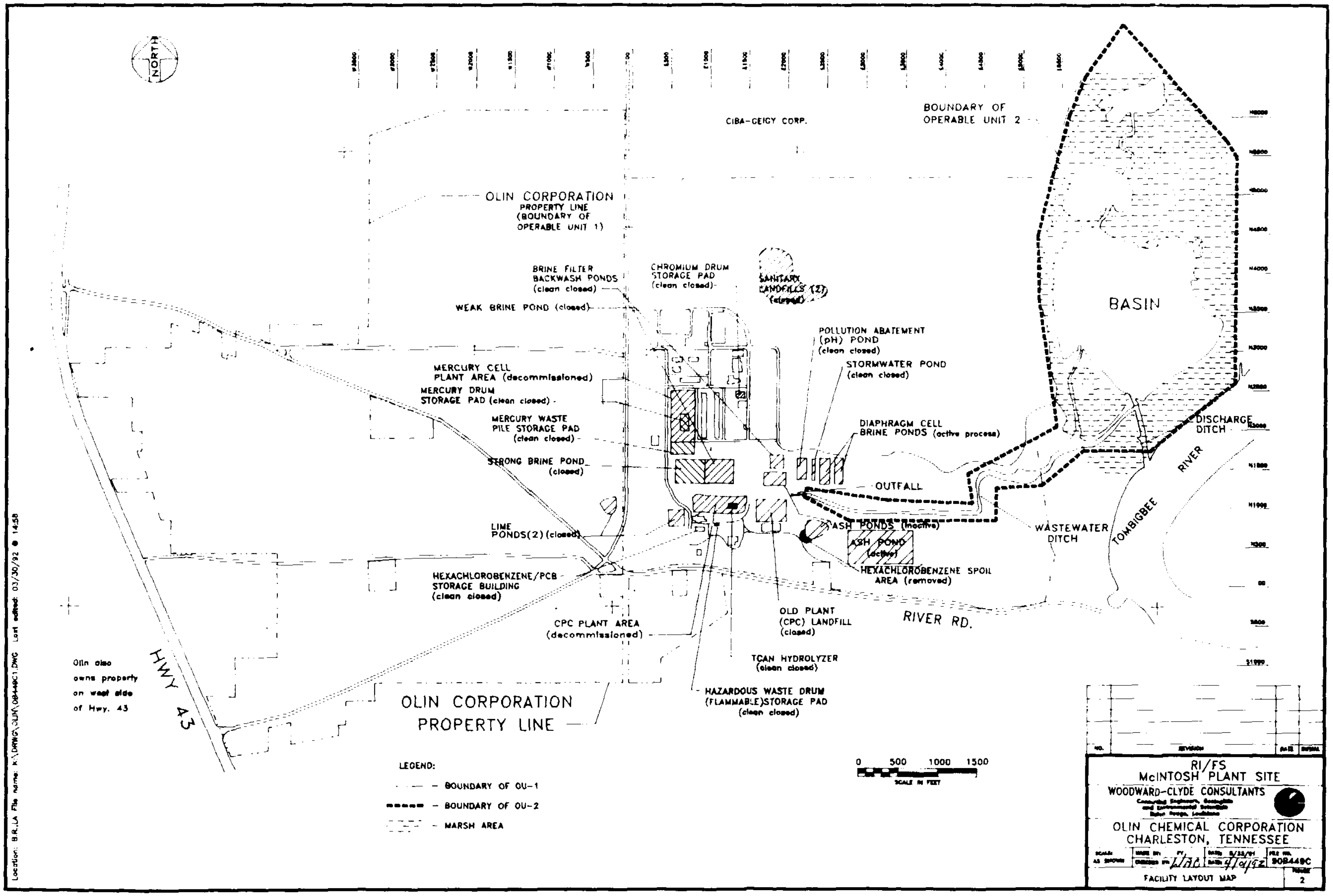
Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists
Baton Rouge, Louisiana

OLIN CHEMICAL CORPORATION
CHARLESTON, TENNESSEE

SCALE: AS SHOWN	MADE BY: SJL	DATE: 12/90	FILE NO. 90B449C
	CHECKED BY: WAG	DATE: 12/90	

SITE LOCATION MAP — FIGURE 1

RE: U.S.G.S. 7.5 MINUTE SERIES QUADRANGLE MAP, McINTOSH, ALABAMA, 1984 AND GINHOUSE ISLAND, ALABAMA, 1984.



NORTH
CIBA-GEIGY CORP.
BOUNDARY OF
OPERABLE UNIT 2
OLIN CORPORATION
PROPERTY LINE
(BOUNDARY OF
OPERABLE UNIT 1)
BRINE FILTER
BACKWASH PONDS
(clean closed)
CHROMIUM DRUM
STORAGE PAD
(clean closed)
SANITARY
LANDFILLS (2)
(closed)
WEAK BRINE POND (closed)
BASIN
POLLUTION ABATEMENT
(pH) POND
(clean closed)
STORMWATER POND
(clean closed)
MERCURY CELL
PLANT AREA (decommissioned)
MERCURY DRUM
STORAGE PAD (clean closed)
MERCURY WASTE
PILE STORAGE PAD
(clean closed)
DIAPHRAGM CELL
BRINE PONDS (active process)
DISCHARGE
DITCH
STRONG BRINE POND
(closed)
OUTFALL
RIVER
TOMBIGBEE
LIME
PONDS(2) (closed)
ASH PONDS (inactive)
ASH POND
(active)
WASTEWATER
DITCH
HEXACHLOROBENZENE/PCB
STORAGE BUILDING
(clean closed)
HEXACHLOROBENZENE SPOIL
AREA (removed)
CPC PLANT AREA
(decommissioned)
OLD PLANT
(CPC) LANDFILL
(closed)
RIVER RD.
TCAN HYDROLYZER
(clean closed)
HAZARDOUS WASTE DRUM
(FLAMMABLE)STORAGE PAD
(clean closed)
Olin also
owns property
on west side
of Hwy. 43
HWY 43
OLIN CORPORATION
PROPERTY LINE
LEGEND:
- BOUNDARY OF OU-1
- BOUNDARY OF OU-2
- MARSH AREA
0 500 1000 1500
SCALE IN FEET
RI/FS
McINTOSH PLANT SITE
WOODWARD-CLYDE CONSULTANTS
OLIN CHEMICAL CORPORATION
CHARLESTON, TENNESSEE
90B449C
FACILITY LAYOUT MAP
2
Location: B.R.,LA File name: K:\DRWG\OLIN\0B449C1.DWG Last edited: 03/30/92 @ 14:58

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